



Fermilab
Beams Division
NuMI Project

“SOPHISTICATED” BEAM PERMIT SYSTEM

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AN INTRODUCTION

Fermilab Has

- **Lots of Accelerators**
- **Lots of Uses for Beam**
 - **Lots of Studies**

How Do We Schedule All of This?

MACHINE CLOCKS

Tevatron Time Clock - "TCLK"

10 MHz Clock with Embedded "Events"
Events Are Unique & Well Defined
Certain Events Serve as Accelerator Resets
Implements Accelerator Scenarios

Time Line Generator
A Programmable Source of Events
Especially Machine Resets

Beam Synchronous Clocks

~7.5 MHz Derived from RF Systems
Revolution Frequency Event
Events to Initiate Beam Transfers

Why and How Do We Control Beam?

NuMI SIGNIFICANT CLOCK EVENTS

TCLK	DEFINITION	COMMENT
\$23	Main Injector Cycle Reset for NuMI Operations	Always Has Beam for NuMI. May Have Beam for P-Bar Production.
\$A5	NuMI Reset for Extracted Beam	Expected to be Synchronous With and Well in Advance of NuMI Extracted Beam. Expected to Happen After \$23 But Before the First \$19.
\$14	Booster Reset for P-Bar Production Beam	Normally One High Intensity Batch.
\$19	Booster Reset for NuMI Beam	One to Six Batches if P-Bar Production Beam is Not in Timeline. One to Five Batches if P-Bar Production Beam is in Timeline.
\$52	Beam for Previous Booster Reset Will Be Accelerated.	A Generic Event.
\$53	Beam for Previous Booster Reset Will Not Be Accelerated.	A Generic Event.
\$1F	Booster Beam About to be Transferred to Main Injector	A Generic Event.
\$22	Main Injector Ramp Begins	A Generic Event.
\$25	Main Injector Flattop	A Generic Event.
\$81	Reflected MIBS Event \$79	Expected to be Synchronous Within a Few Microseconds.
\$A9	Reflected MIBS Event \$74	Expected to be Synchronous Within a Few Microseconds.
\$27	Detected Fall of the Main Injector Beam Permit	Fires the Abort Kicker
\$2F	Fire the Main Injector Abort	Happens Every Cycle.
\$26	End of Beam Operations in the Main Injector	All Beam Should be Gone.
\$A6	NuMI Beam Permit Has Fallen to Non-Permit State	Serves to Inhibit Accelerating Beam Associated With Booster \$19 Reset. Also Will Inhibit Generation of MIBS \$74.
\$A8	NuMI Beam Permit System Reset	Issued by Operator Command. Received by C200 and C201 Modules. Clears Latched Inputs of C200.
\$FA	Reflected MIBS \$ED	A Generic Event.

MIBS	DEFINITION	COMMENT
\$AA	Main Injector Revolution Marker	Once Every 588 RF Cycles. Approximate 10 Microsecond Period.
\$79	Initiate Transfer of 120 GeV P-Bar Production Beam to P-Bar Target	Reflected as TCLK \$81.
\$74	Initiate Transfer of 120 GeV NuMI Beam to NuMI Primary Beamline	Reflected as TCLK \$A9.
\$ED	Request for a MIBS Transfer Event Has Been Denied	Reflected as TCLK \$FA. This is a Generic Event. If One Expects to See \$74 or \$79 and Does Not, This \$ED Event Should Be Generated.

\$29 P-Bar Production Cycle Timing Observations

Event	Description / Comment	Time in Milliseconds
\$80	3 x 15 Hz Ticks Before \$29 MI Reset or -201 ms	-201.0
\$29	Main Injector Reset	0.0
\$22	Start of Ramp	89.0
\$25	Start of Flattop	778.9
MIBS \$79	Initiate P-Bar Production Beam Transfer	838.9
	MI-52 Kicker Fire Time MIBS \$79 + 24.918 MR Rev	839.2
\$26	End of Beam Operations	848.9
	Total \$29 Cycle Time	1,470.0
	Flattop to Actual P-Bar Production Beam Extraction	60.3

Why?

We Don't Want to Introduce Beam to the
Accelerator Complex Unless It Is Wanted
(TLG and Operators)

We Don't Want to Introduce Beam Unless the Path
to the Destination Is Clear
(Beam Permits)

How?

Beam Switch Sum Box

Accepts TCLK (Scenarios)

Accepts Beam Permits

Accepts Operator Input (Switches)

Sources Pulse Shift Command to Source

NuMI Operational Goals

- 1. Hit Production Target Consistently**
- 2. Efficient Beam Transmission**
- 3. Minimize Component and Groundwater Activation**
 - 3A. Avoid “Accidental” Beam Losses**
 - 3B. Prevent Multiple “Accidental” Beam Losses**
 - 3C. Minimize “DC” Beam Losses**
- 4. Conform to Developed Safety Envelope**

SOLUTION

Utilize Existing Infrastructure

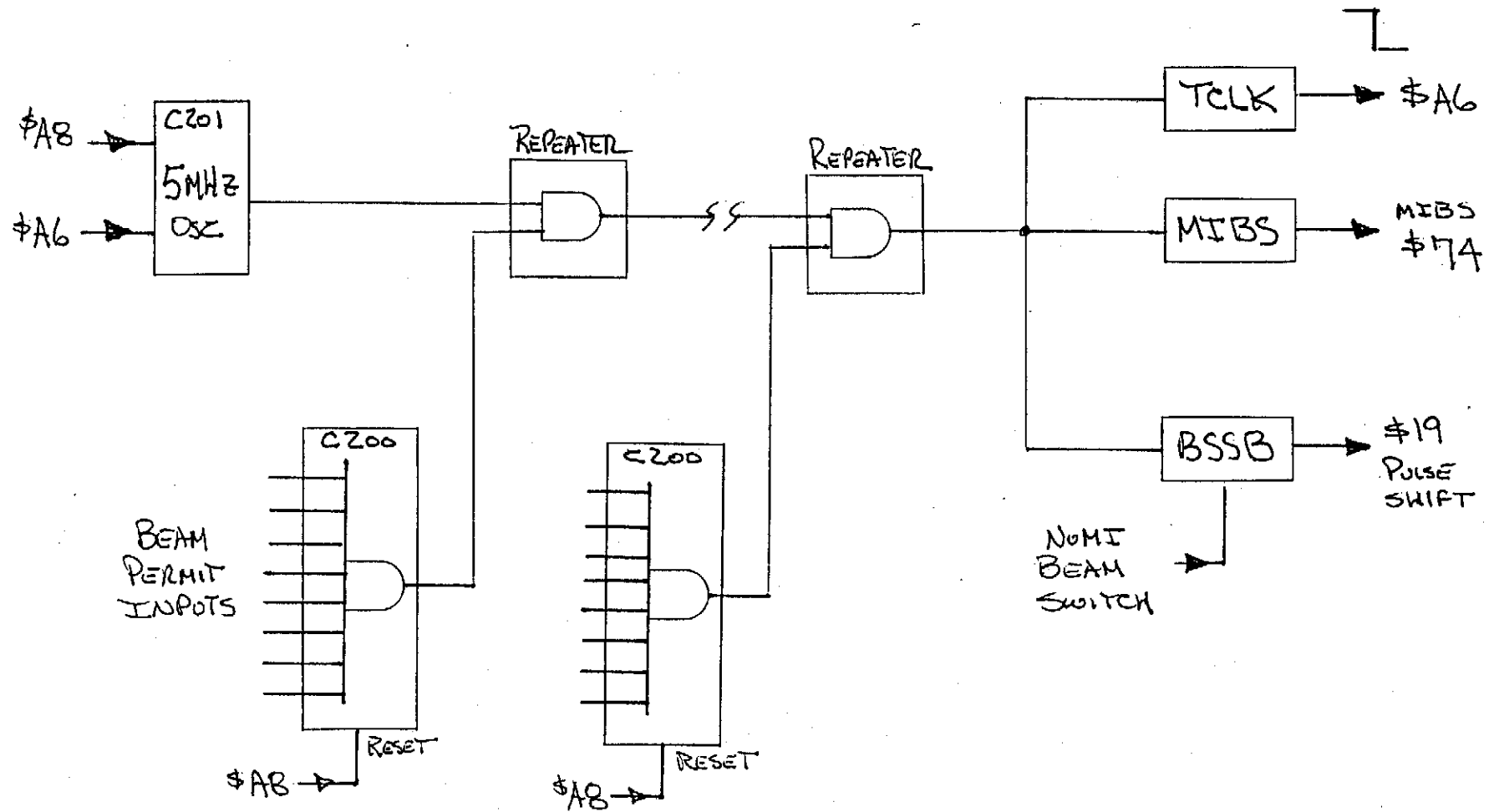
Establish a NuMI Beam Permit System

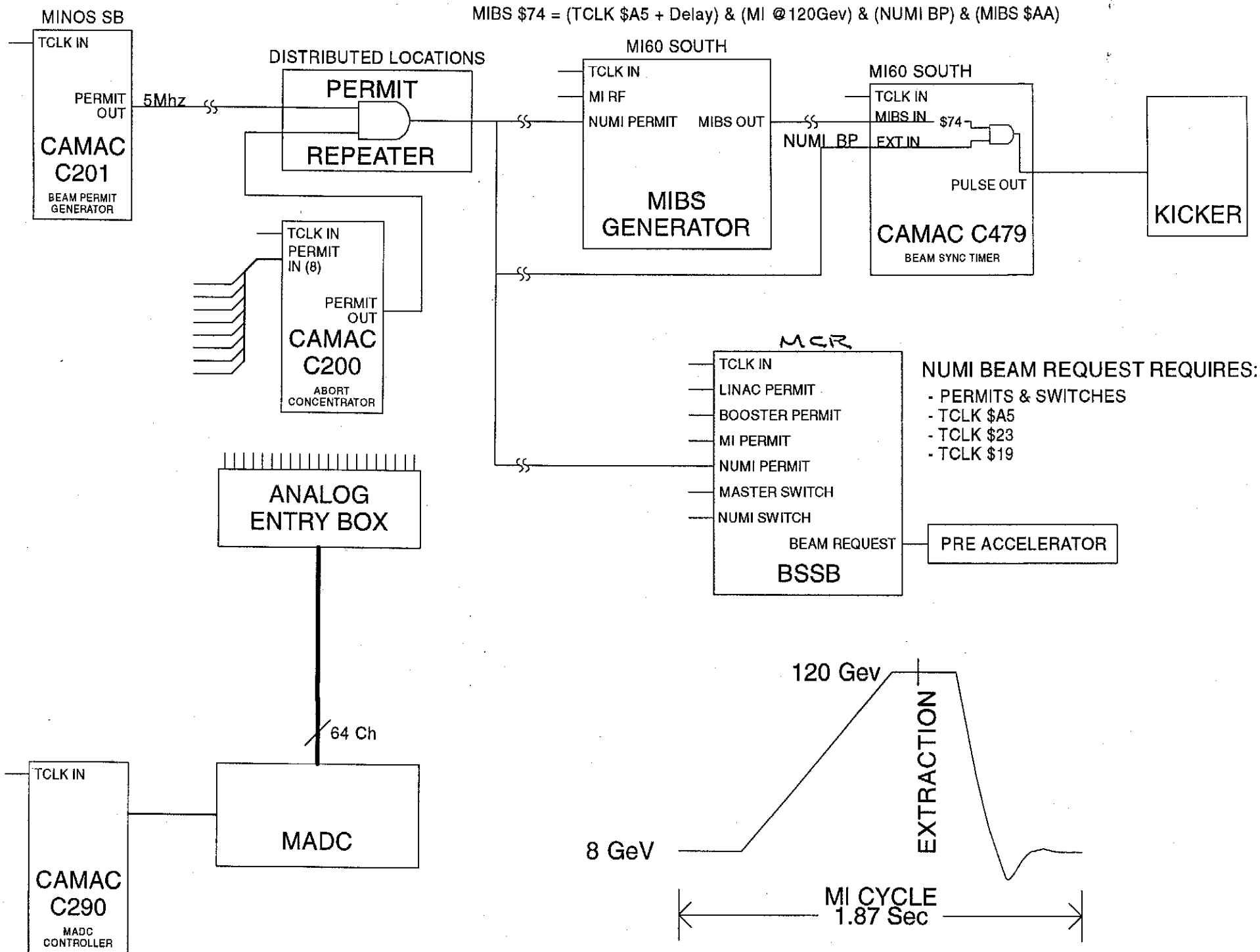
**Inputs Need to Be More
“Sophisticated”**

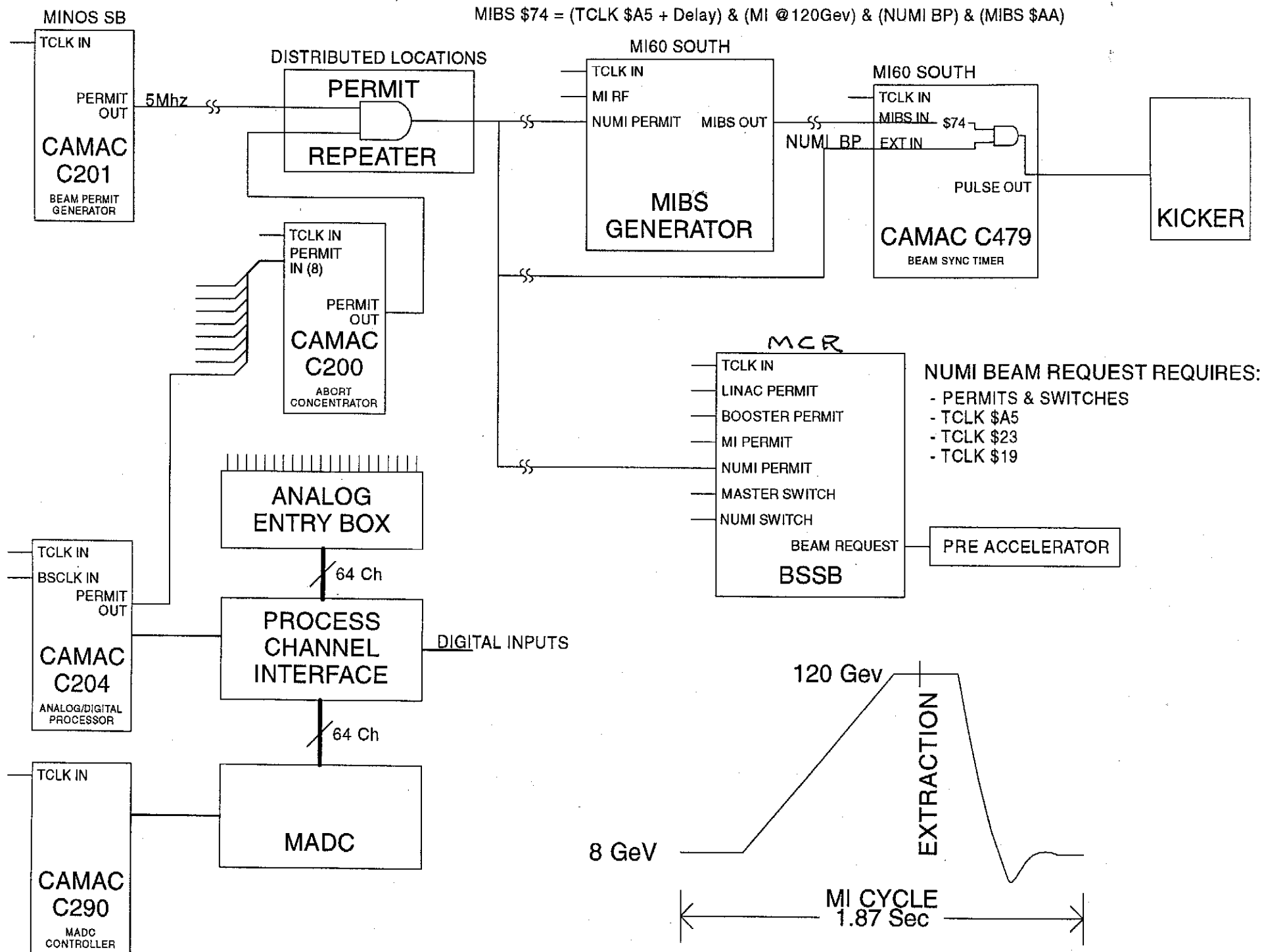
Going Beyond the Steady State

**New Development of
Process Channel Interface (PCI)
&
Companion CAMAC C204**

NUMI BEAM PERMIT SYSTEM







Unique Features of the PCI & C204

- Output Compatible with Beam Permit System
- Up to 64 Analog and 32 Digital Inputs
- Dedicated 16 Bit A/D Converter
80 Microsecond Convert Time
- Download Channel Configuration
- Download High or Low Limits or Both
- Capability of Two Different High Limits in Accord With Beam Intensity
- Channels Individually Maskable
- A/D Conversion Triggered by a State Algorithm Table or "SAT"
- Four Dedicated Timer Channels for Use By SATs
- Process Time per Channel Less Than 5 Microseconds
- Plan to Test Just Before and After Extractions

Z14

Camac 204 Interface

◆Pgm_Tools◆

system	module	channels	TABLES
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State Algorithm Tables
Table -<1>+ of Module -<ABS>+

Table Entry	Clock Source	Clock Event	Assoc Delay	0=Proceed 1=Trigger	# Subsequent Entries
1	TCLK	23	None	0	3
2	TCLK	22	TD0 None	0	2
3	TCLK	25	TD0 None	0	1
4	BSCLK	74	TD1	1	0
5	....	..	...	.	.
6	....	..	...	.	.
7	....	..	...	.	.
8	....	..	...	.	.
TD0.....	0.000100 s		*Display All Tables For Module ABS		
TD1.....	0.002000 s		*Enable Table Edits For Module ABS		
TD2.....	0.000300 s		*Copy Table < > of Module ABS		
TD3.....	0.005700 s		to Table < > of Module-< >+		

Messages

NuMI BEAM PERMIT INPUTS - SUMMARY SHORT LIST

4-Sep-01

DESCRIPTION	QTY	EXPANDED LIST	COMMENT
Safety System	1	NuMI Radiation Safety System	Available at MI-60N
Main Injector Performance	3	Beam Quality, Bunch Length, No P-Bar Beam	Beam Quality to Include RF and Radial Position As Nominal
Special Supplies	2	Kicker and Horn	Operational Status and Cap Bank Voltage
Bend Supplies	7	LAM60, V100, HV101, V104, V105, V109, V110	Operational Status and Current
Quad Supplies	10	Q101 thru Q110	Operational Status and Current
Correctors	12	HT and VT 102, 103, 105, 107, 108, 110	Operational Status Only
Profile Monitors	7	PM103, 104, 105, 107, 108, 110, 111	Must Not be Between IN and OUT Positions
Loss Monitors	39	35 Sealed BLMs and 4 Total Loss Monitors	Test After Extraction and Possibly Before
Vacuum	6	Beamline and Decay Pipe Pressure, 4 Valve Positions	Pressure Nominal and Valves Open
Water Systems	6	MI-62 LCW, Target and Baffle RAW, Horn 1 RAW, Horn 2 RAW, Absorber RAW, Decay Pipe RAW	System Operation Nominal
Temperature	5	Downstream Baffle, Target, Horns and Absorber	Thermocouple Information